SELECTIVE ELECTRO-PLATING ETCHING OR ELECTRO-MACHINING

Patent number:	GB1521130
Publication date:	1978-08-16
Inventor:	
Applicant:	STANDARD TELEPHONES CABLES LTD
Classification:	
- international:	C25D5/02; C25D5/20; C25F3/02
- european:	C25D5/02; C25D5/20
Application number:	GB19750049405 19751202
Priority number(s):	GB19750049405 19751202

Also published as:

- FR2333876 (A1)
- ES453877 (A)
- BE848966 (A)

Abstract of **GB1521130**

1521130 Selective electro-plating, etching or electro-machining STANDARD TELEPHONES & CABLES Ltd 30 Nov 1976 [2 Dec 1975] 49405/75 Heading C7B Conductive workpieces are selectively electro-plated e.g. connector parts mounted on a moving band, by at least partially immersing cathodically connected workpieces in a plating bath e.g. Ni and Au plating tanks, whilst selectively subjecting immersed portions of the workpieces to ultrasonic radiation of a wavelength shorter than the shortest dimension of the irradiated portions so that no cavitation of electrolyte is produced. The ultrasonic radiation may be generated from a lead zirconate/ titanate Piezo-electric transducer driven from an oscillator via an RF amplifier, the transducer resonating at the oscillator frequency; a polymethyl methacrylate lens may be mounted in front of the transducer. The process is also applicable to selective electro-machining and etching e.g. for producing Cu printed circuit board.

PATENT SPECIFICATION

(11) 1 521 130

1 521 130

(21) Application No. 49405/75 (22) Filed 2 Dec. 1975

(23) Complete Specification filed 30 Nov. 1976

(44) Complete Specification published 16 Aug. 1978

(51) INT CL.[2] C25D 5/02 5/20 C25F 3/02

(52) Index at acceptance

C7B 120 151 152 209 303 327 722 727 AL

(72) Inventor MILES PATRICK DRAKE

(19)

(54) SELECTIVE ELECTRO-PLATING, ETCHING OR ELECTRO-MACHINING

(71) We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company, of 190 Strand, London, W.C.2., England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electromachining, and to selective electroplating or etching of metal ions to or from an electrically conductive work-piece.

Selective electroplating of work-pieces such as electrical connector blades to provide contact making areas of a noble metal (i.e. one of the metals such as gold, silver, platinum, palladium or rhodium which are used for contact-making surfaces) to a controlled thickness and area definition is of increasing importance for the economic and efficient use of the gold or other contact metal. In such plating operations deposition of the metal is restricted to a defined region of the work-piece to save materials. Similarly it is often necessary to etch selectively part of a work-piece, e.g. in electro-machining operations. Present techniques involve either masking or partial immersion of the workpiece in the plating or etching solution.

The rate of a plating or etching process is usually limited by the diffusion rate of ions across the metal/electrolyte boundary. The diffusion or transport rate of the ions across the boundary may be increased by agitation of the electrolyte in the boundary region. A known method of providing this agitation is to irradiate the workpiece and the surrounding electrolyte by ultrasonic radiation. This method, whilst enhancing plating or etching, is however non-selective.

According to one aspect of the invention there is provided a process for the selective enhancement of the transport rate of ions across a metal electrolyte boundary during an electromachining electro-plating or etching operation, which process includes irradiating at least a portion of the boundary with a locally intense field of sonic waves at ultrasonic frequency, said irradiation locally agitating the electrolyte, the frequency of said irradiation being sufficiently high to ensure that substantially no cavitation of the electrolyte is produced.

According to another aspect of the invention there is provided a selective electroplating or etching apparatus, including a bath for electromachining, electro-plating or etching, means for providing electrical connection to a conductive work-piece at least partially immersed in the bath, and means for irradiating a selected immersed portion of the work-piece with sonic waves at an ultrasonic frequency, said irradiation being effective to locally agitate the electrolyte.

The ultrasonic field is spatially defined on the workpiece either by imaging or shadowing techniques, or by focussing the sound energy on to an area of the work-piece surface. In order to achieve the required definition the ultrasonic radiation must be of a high enough frequency for the wavelength to be comparable with or, preferably, smaller than the required resolution unless a closely fitting mask is employed. This means that the wavelength should be shorter than the shortest dimension of the irradiated portion. In aqueous solutions the wavelength of ultrasound is given approximately by the expression $\lambda = {}^{1.5}/_{f}$ mm where f is the frequency in MH_z. Hence for good definition in the 1 mm range frequencies greater than 1 MH_z are required. Furthermore, at such frequencies, cavitation does not occur at the energy intensities required so that strong agitation by acoustic streaming may be achieved without the risk of cavitation erosion.

An embodiment of the invention will now be described with reference to the drawing accompanying the Provisional Specification which shows an ultrasonic selective electroplating/etching apparatus.

Referring to the drawing, a plane parallel lead zirconate/titanate transducer 1 is mounted in a watertight polymethyl methacrylate box 2, immersed vertically in a gold plating bath 3. A polymethyl methacrylate lens 4 is mounted

in front of the transducer 1 such that the ultrasonic radiation generated thereby is brought to a focus 7 cm from the lens 4.

A strip 5 of cleaned nickel-silver, 0.5 cm wide, is immersed in the electrolyte such that the ultrasonic radiation is brought to a focus at the face portion 6 of the strip. A platinised titanium grid 7 immersed in the bath series as an anode.

In operation, the transducer was energised at 1.1 MHz and the strip 5 made cathodic to 3V. After 1 minute the strip was removed and washed. An area 6 of 4 mm diameter on the transducer side of the strip, was gold-plated to a thickness of 1.2 μ, while the rest of the immersed strip was plated to a thickness of 0.2—0.3 μ.

By the use of higher potentials applied to the workpiece, the preferential plating may be carried out at much higher current density, enabling, for example, 2 μ of gold to be plated on the spot in 20 secs., with 0.1—0.2 μ elsewhere.

The transducer may be driven from an oscillator via a radio frequency power amplifier. The transducer is preferably resonant at the oscillator drive frequency.

The transducer 1 may advantageously be prepared from a plate of piezo electric material ground to a thickness corresponding to the desired frequency. In a typical construction a transducer may be formed from a plate of lead zirconate/titanate PZT material, e.g. Channel Industries type 5400, ground to a thickness of 0.080 inches $\pm$ 0.0005 inches corresponding to a fundamental thickness resonance of 1.0 MHz. The plate is bonded to one face of a resonant aluminium alloy bar, the opposite face of which is bonded to the plane side of a plano-convex polymethyl methacrylate lens. This material is marketed under the Registered Trade Mark Perspex. The assembly is then mounted on a Perspex trough and sealed to form a water-tight construction, the piezo-electric element having an air backing.

Electrical contact to the PZT plate is made via a 50 ohm coaxial cable previously sealed through the trough and coupled to the plate and to the aluminium alloy bar.

The following example illustrates the invention.

Example

A transducer assembly comprising twelve transducers of the type previously described was mounted in a gold plating tank of a reel to reel partial immersion automatic plating machine. In such a machine connector parts mounted on a band are moved continuously through cleaning, nickel plating and gold plating tanks.

The transducer assembly was adjusted so that the ultrasonic energy was focussed in a line across the region of partially immersed connector parts where the thickest gold deposit was required, i.e. the contact area. The solution level was adjusted so that the contact area was just submerged. The transducers were excited at a frequency of 1.0 MHz at an input power of 67.5 watts per transducer.

Connector parts, after passing through the standard pretreatment tanks, were run at 2 ft/min through the gold plating tank containing Engelhard 86 HE gold plating solution with a gold concentration of 4 g/litre. Platinised titanium anodes were employed and a current corresponding to a density of 4 amps/dm^2 of immersed connector area was passed. The connector parts were in the gold tank for a total of three minutes.

On removal from the tank the connector parts were found to have a thickness of 2 micron of bright gold on the contact area, 0.5 micron on the reverse side and 1.5 micron above and below the contact area.

This represents a considerable gold saving over conventional gold plating processes.

The process is not of course limited to electroplating. As the action of the focussed ultrasound is to increase the transport rate of ions across the metal/electrolyte boundary, the process may also be employed for selective etching and electromachining. For example, such a process may be employed for the production of a printed circuit board from a copper clad insulating board.

WHAT WE CLAIM IS:—

1. A process for the selective enhancement of the transport rate of ions across a metal/electrolyte boundary during an electromachining, electro-plating or etching operation, which process includes irradiating at least a portion of the boundary with a locally intense field of sonic waves at ultrasonic frequency, said irradiation locally agitating the electrolyte, the frequency of said irradiation being sufficiently high to ensure that substantially no cavitation of the electrolyte is produced.

2. A process for the selective electroplating of an electrically conductive work-piece, in which a cathodically connected work-piece is at least partially immersed in a plating bath and an immersed portion of said work-piece is subjected selectively to radiation by sonic waves at an ultrasonic frequency of a wavelength shorter than the shortest dimension of the irradiated portion, said irradiation being effective to locally agitate the electrolyte.

3. A process for the selective electroplating of an electrically conductive work-piece, which process is substantially as described herein with reference to the drawing accompanying the Provisional Specification.

4. A selective electroplating or etching apparatus, including a bath for electromachining, electroplating or etching, means for providing electrical connection to a con-

ductive work-piece at least partially immersed in the bath, and means for irradiating a selected immersed portion of the work-piece with sonic waves at an ultrasonic frequency, said irradiation being effective to locally agitate the electrolyte.

5. An apparatus as claimed in claim 4, and in which said sonic waves are generated by a piezo-electric transducer driven from an oscillator and a power amplifier, said transducer resonating at the oscillator frequency.

6. An apparatus as claimed in claim 5, and in which the active element of said transducer is a plate of lead zirconate/titanate piezo-electric material ground so as to resonate at the oscillator frequency.

7. An apparatus as claimed in claim 5 or 6, and in which said transducer is mounted in a plastics box with a lens mounted adjacent thereto to focus the ultrasonic waves generated by the transducer.

8. A selective electroplating apparatus substantially as described herein with reference to the drawing accompanying the Provisional Specification.

9. A work-piece selective electro-plated or etched by a process as claimed in claim 1, 2 or 3.

S. R. CAPSEY,
Chartered Patent Agent,
For the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1521 130 PROVISIONAL SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.